



IN THE CLAIMS:

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Please add claims 2-21 as follows:

2. (New) A method, comprising:

a' performing a simulation of a thermal fluid flow in a die for a casting or molding process, the simulation including a model of at least one of: a shot sleeve and ram for the die as a function of ram position, shrinkage of a casting as a function of porosity, a heat transfer line embedded in the die, die lubricant cooling, and mend line formation;

establishing a finite element mesh for a domain of the thermal fluid flow;

determining mass flux relative to the finite element mesh;

updating a velocity field, a pressure field, and a temperature field relative to the finite element mesh, said updating including calculating the velocity field as a function of the pressure field; and

repeating said updating until a convergence test is satisfied.

3. (New) The method of claim 2, which includes incrementing a simulation time interval and repeating said determination until a stop simulation criterion is met.

4. (New) The method of claim 2, wherein said updating the pressure field and velocity field is based on conserving momentum and mass according to a control-volume based finite element formulation.

5. (New) The method of claim 2, wherein the simulation includes the model of the shot sleeve and ram for the die, and the model is further provided as a function of one or more dwell parameters.

6. (New) The method of claim 5, wherein said updating includes determining the temperature field according to non-coincident heat transfer between the shot sleeve, the ram, and the thermal fluid flow.

7. (New) The method of claim 2, wherein the simulation includes the model of the shrinking of the casting as a function of porosity and further comprising:

defining an expression for the porosity as a function of density;

identifying nodes with negative pressure;

creating a reduced pressure gradient field; and

determining incremental porosity from the reduced pressure gradient field.

8. (New) The method claim 2, wherein the simulation includes the model of the heat transfer line embedded in the die, and further comprising:

representing the heat transfer line with a number of segments each bounded by a corresponding pair of a number of nodes;

determining temperature at each of the nodes;

determining heat transfer between the die and a fluid in the heat transfer line based on the temperature of each of the nodes; and

determining the temperature field as a function of the heat transfer.

9. (New) The method of claim 2, wherein the simulation includes the model of the die lubricant cooling, and further comprising:

providing one or more thermal properties of a spray lubricant applied to the die with a nozzle;

determining a cooling coefficient for the spray lubricant; and

computing heat loss from one or more elements of the die by application of the lubricant.

10. (New) A method, comprising:

providing a model of a heat transfer line in a die for casting or molding, the model including a number of segments each associated with one or more element surfaces of the die and a corresponding number of nodes, the model being provided in a one-dimensional form;

determining heat transfer between the die and fluid in the heat transfer line with the model as a function of temperature at each of the nodes and Reynolds, Prandtl, and Nusselt numbers; and

simulating a thermal fluid flow in the die based on the heat transfer.

11. (New) The method of claim 10, which includes linearly interpolating temperature between pairs of the nodes.

12. (New) The method of claim 10, wherein the model corresponds to the one-dimensional energy equation.
13. (New) The method of claim 12, wherein a heat transfer coefficient is determined as a function of the Nusselt, Pandtl and Reynolds numbers.
14. (New) The method of claim 10, wherein said simulating includes updating a temperature field of a finite element mesh representative of a flow domain for the fluid flow.
15. (New) A method, comprising:
- simulating a fluid flow with one or more melt fronts;
  - representing particles on the one or more melt fronts with a number of different visual symbols;
  - displaying movement of the different visual symbols to show melt front advancement over time; and
  - indicating mend line formation where two or more of the different visual symbols meet one another and stop moving while other of the different visual symbols continue to move during said displaying.
16. (New) The method of claim 15, wherein the different visual symbols vary with at least one of: time of creation and temperature.

17. (New) The method of claim 15, further comprising providing data from a thermal flow simulation.

18. (New) The method of claim 15, further comprising evaluating quality and strength of mending from a level of mixing of the different visual symbols.

19. (New) A method, comprising:

performing a simulation of a thermal fluid flow for a casting or molding process, the process including application of a lubricant spray to a die with a nozzle;

modeling the application of the lubricant spray in the simulation as a function of a number of spray parameters, a motion profile of the nozzle, and a cooling coefficient; and

determining heat loss from the die in response to the application of the lubricant spray with the simulation based on said modeling.

20. (New) The method of claim 19, wherein the simulation includes a model of at least one of: a shot sleeve and ram for the die as a function of ram position, shrinkage of a casting as a function of porosity, a heat transfer line embedded in the die, and mend line formation.

21. (New) The method of claim 19, wherein the cooling coefficient is determined from a look-up table.